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Contribution from the Bureau of Entomology, L. O. Howard, Chief.

THE BAGWORM, AN INJURIOUS SHADE-TREE INSECT.[1]

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GENERAL APPEARANCE AND NATURE OF ATTACK.

Shade trees, shrubs, and hedges, and in particular evergreens, are much subject to injury by a caterpillar which has a curious habit of crawling about on the infested trees in a baglike case, whence its common name of bagworm or basket worm.[1] In the shelter of these cases the insects undergo all their transformations, after which the bags remain attached to the plants for some time and are conspicuous objects on leafless trees and shrubs in late autumn and in winter. Like the tussock moth[2] and the fall webworm[3] this species is preeminently a pest on trees and shrubs along streets and in parks and private grounds of cities and towns and even more than these is subject to fluctuation in numbers. It is, however, more limited in distribution than the two insects mentioned and not found as a rule

[1] *Thyridopteryx ephemeraeformis* Haworth; order Lepidoptera and family Psychidæ.
[2] *Hemerocampa leucostigma* S. & A.
[3] *Hyphantria cunea* Dru.

NOTE.—This bulletin is suitable for distribution in the southeastern portion of the United States.

north of southern New York and the central portions of Pennsylvania and Ohio. South of these points it is in certain years very troublesome and the subject of much complaint. Such a year was 1907, when the bagworm attracted greater attention than any other tree defoliator. Numerous complaints were received of injuries in the region mentioned, especially from the States of New Jersey, Pennsylvania, Maryland, Virginia, West Virginia, Ohio, Indiana, and Illinois. The natural enemies of this insect (see p. 7) were comparatively scarce, and there is a strong possibility of a recurrence of injuries in the years to come.

FIG. 1.—Bagworm (*Thyridopteryx ephemeraeformis*). Natural size. (After Riley.)

The general appearance of the bagworm is shown in figure 1, which illustrates the caterpillar when nearly full grown in its characteristic bag. When removed from its bag it looks as shown in figure 2, *a*, which represents the full-grown larva. At this period in its development it may attain a length of about three-fourths of an inch. The body is soft in texture and dull brownish or blackish, while the head and thoracic segments are horny and whitish, mottled with dark brown.

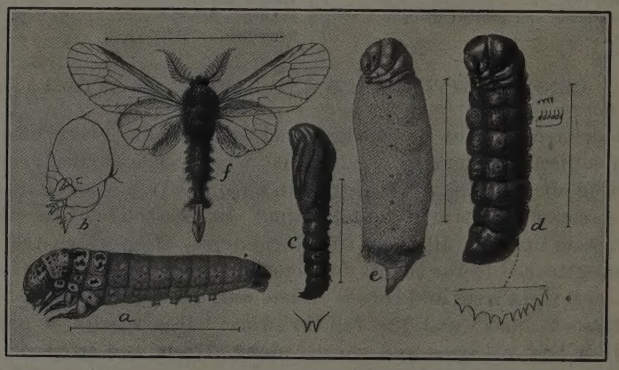

FIG. 2.—Bagworm (*Thyridopteryx ephemeraeformis*): *a*, Full-grown larva; *b*, head of same; *c*, male pupa; *d*, female pupa; *e*, adult female; *f*, adult male. All somewhat enlarged. (From Howard.) N. B.—The various stages are in reality a trifle longer than they are shown by the hair lines.

ORIGINAL HOME AND PRESENT DISTRIBUTION.

The bagworm is unquestionably native to North America. It abounds in the Southern States, except in the immediate Gulf region,

but is found farther to the north, and there are indications that it has gradually spread into this territory from more southern regions.

The map (fig. 3) which shows the region in which injury by the bagworm has been reported up to the year 1907 by black areas, and again during the two years 1913 and 1914 by shaded areas, as authenticated by the files of the Bureau of Entomology, may indicate that the species tends to spread toward the south and west. This apparent tendency, however, may be due merely to the planting of more trees in the more thickly populated towns and cities in such States as Oklahoma.

FOOD PLANTS.

The bagworm, although a very general feeder, displays a particular fondness for evergreens of all kinds, especially for arbor-

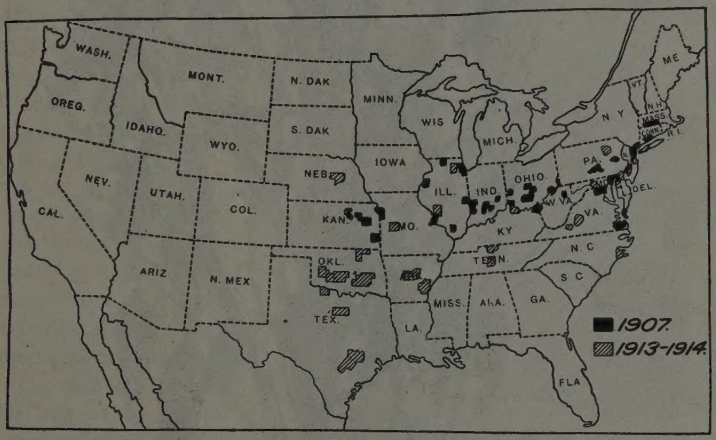

FIG. 3.—Map showing, by black areas, localities in which injury by the bagworm has been reported up to 1907 and, by shaded areas, those in which injury was reported in 1913 and 1914. (Original.)

vitæ (fig. 4); hence it seems probable that one or the other of these was its original or normal food plant. The species becomes exceedingly abundant every few years, and at such times it may be found on shade, orchard, and forest trees of nearly every kind. It is fond of willows and maples, particularly the silver maple and its varieties and the related boxelder; it is also fond of the poplars and mulberry, less so of the elms, and apparently still less so of the oaks. It feeds more or less freely, however, on most other trees and shrubs, and even on many low-growing semiwoody plants, such as elder, mallow (Hibiscus), and ragweed.[1] Thus in the absence of its choice food plants it is able to subsist on the foliage of almost any of the

[1] *Ambrosia trifida.*

FIG. 4.—Arborvitæ infested by bagworms. (Authors' illustration.)

plants of the character enumerated which may be available, but it does not seem to live on grasses and herbaceous plants generally.

HABITS AND LIFE HISTORY.

The bagworm overwinters in the egg stage within the old female bag, and for this reason hand picking in wintertime is an efficacious remedy. In the late spring the young hatch from the eggs, crawl out upon the twigs, make their way to the nearest leaf, and immediately begin to feed and to construct cases or bags for themselves. They spin a large quantity of silk, and attach to it for additional strength and protection bits of leaf or twig, evidently attempting to disguise the nature of the case as well as to strengthen it. The larva is remarkably soft-bodied, except for its head and strong thoracic plates, and it is necessary that the soft abdomen should have some protection.

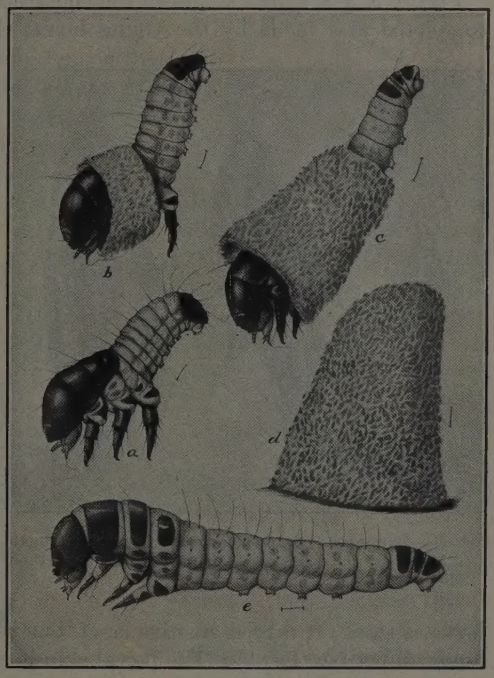

FIG. 5.—*a*, Newly hatched bagworm before making its case; *b*, same, just beginning case; *c*, same, with its case nearly completed; *d*, completed case, insect concealed within; *e*, larva after first molt. Highly magnified. (Authors' illustration.)

The construction of the bag of an allied species of similar habits has been described as follows: The young larva cuts off with its jaws a small fragment of leaf which it places between its front legs, gradually forming a pile fastened loosely with silk. When the pile becomes a transverse tangle about as long as the body, it is fastened at each end loosely to the surface upon which it rests; then the caterpillar, after placing itself at right angles, dives under the

mass, turning a complete somersault, so that it lies on its back, bound down by the fillet. It then twists around and stands upon its feet, having its neck under a sort of yoke. It makes the yoke into a complete collar, adding bits to each end until the circle is complete. Then row after row of fragments is added until the case becomes a hollow cylinder. One end is then closed up, and the inside lined with a tough coating of silk, the case being then extended upright and fastened at one end. When it is fully completed, the larva crawls away with the case carried upright like a cap on the upturned end of its body.

Figure 5, *a–c*, shows stages in the construction of the case and *d* a completed case made by the young larva, tightly appressed to the flat surface, the larva being concealed within. Such bags frequently be found on leaves, and are quite puzzling to the uninitiated until the larva pokes out its head and slowly walks off.

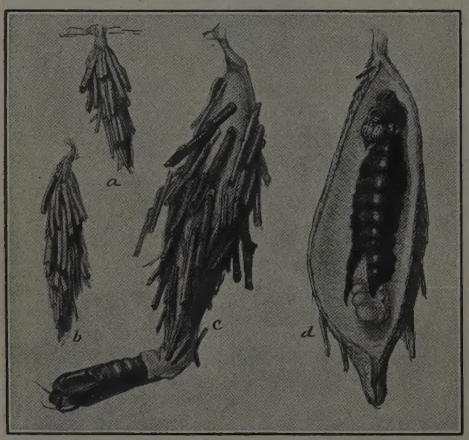

FIG 6.—Bagworm at (*a, b, c*) successive stages of growth. *c*, Male bag; *d*, female bag. About natural size. (From Howard.)

As the caterpillar grows, the case is constantly enlarged, bits of twigs and any other small objects being used to ornament the outside, and these objects will vary with the kind of tree upon which the caterpillar is feeding. While the larva is small, it carries its case erect, but when it is larger the case hangs down (see fig. 1). The larval skin is cast four times, and during the molting the mouth of the bag is kept closed with silk. There is a small opening in the extremity of the bag through which excrement and cast skins are pushed. The male bags reach a length of about an inch, while those of the female are much larger.

Toward the end of August, about Washington, D. C., the larva completes its growth, attaches its bag firmly by a silken band to a twig, strengthens it inside with an additional layer of silk, and within this retreat, which now becomes its cocoon, transforms to pupa with its head downward.

The pupal period lasts about three weeks, and then the adult emerges. The male chrysalis works its way out of the lower opening,

and the winged moth issues through the cracking skin, leaving the chrysalis hanging from the bag, as shown at *c*, figure 6. The chrysalis of the female does not push its way at all out of the bag, but the skin cracks and the female gradually works her way partly out of the chrysalis skin, her head reaching the lower end of the bag (fig. 6, *d*). The males fly about seeking the bags of the females, and when one is found in which the head of the female is near the end, showing that she has emerged from her chrysalis skin, the male mates with her. The female then works her way back into the chrysalis skin, gradually filling it with eggs until more than half of it is filled, scattering in among the eggs some of the sparse hairs from her body. Having done this, she forces her shriveled body out of the opening, falls to the ground, and dies. The eggs remain in this way until the following spring when they hatch as previously described. There is thus only one generation annually.

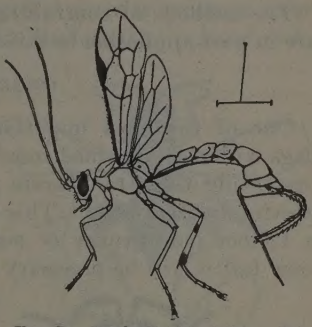

FIG. 7.—*Itoplectis inquisitor:* Female from side. Enlarged. (From Howard.)

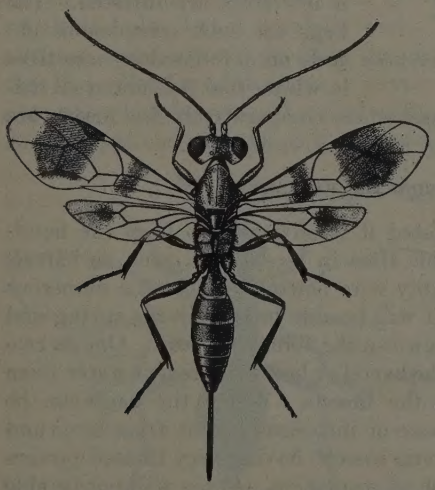

FIG. 8.—*Allocota thyridopterigis.* Much enlarged. (Authors' illustration.)

NATURAL ENEMIES.

Although apparently well protected from the attacks of birds by its tough case, the bagworm is somewhat extensively parasitized by several forms of ichneumon[1] and chalcis flies,[2] most of them species which affect also similar tree-feeding caterpillars.

REMEDIES.

When the bagworm occurs upon deciduous trees it can be controlled by hand picking the bags in the winter, but when it affects evergreen trees it is practically impossible to apply this

[1] (*Pimpla*) *Itoplectis inquisitor* Say (fig. 7), (*Pimpla*) *Itoplectis conquisitor* Say, and (*Hemiteles*) *Allocota thyridopterigis* Riley (fig. 8).

[2] *Spilochalcis mariae* Riley (fig. 9), *Chalcis ovata* Say (fig. 10), *Dibrachys boucheanus* Ratz. (fig. 11), and *Habrocytus thyridopterigis* Ashm. (fig. 12). Certain of these species are undoubtedly hyperparasitic; that is, parasites of the bagworm parasites.

remedy with profit unless the plants are badly defoliated. Therefore, for the treatment of evergreens, spraying is a necessity.

The methods of controlling shade-tree pests in cities and towns[1] are in part applicable to this species.

COLLECTING THE BAGS.

One of the most important remedies consists in gathering the bags with the contained insects by hand and either burning them or preserving them to liberate the useful parasites which have been previously mentioned. This work may be facilitated by the use of a 12-foot pole pruner or similar appliance. Where the trees are very tall it will be necessary to use a long ladder. For best results the cooperation of neighbors who are troubled with the same pest should be secured. Considerable immunity from future injury will result by care in the employment of this method. It is particularly useful where only a few trees are infested. The bags are such conspicuous objects on defoliated or bare trees in winter that it is not at all difficult to detect them, but in cases where comparatively few insects are present on evergreen trees they are not so easily seen.

FIG 9.—*Spilochalcis mariae*. About four times enlarged. (After Riley.)

ENCOURAGING THE PARASITES.

When many trees are infested it is advisable to keep the hand-picked bags for a considerable time in receptacles, such as barrels covered with netting, preferably wire netting, so that the numerous beneficial parasites of the pest will be able to issue in the spring and assist in the control of the bagworm the following year. One or two holes bored in the bottom of the barrel or box will prevent water from accumulating and drowning the insects. Where the bags can be placed in piles in an open space or inclosure distant from trees and free from disturbance, the young insects, having very limited powers of locomotion, will soon perish of starvation, as they will not be able to find the trees or shrubs after they hatch.

SPRAYING WITH ARSENICALS.

On evergreens, where the bags are more or less difficult to find, hand picking can not be advised. A striking instance of the futility

[1] Howard, L. O. Three Insect Enemies of Shade Trees. U. S. Dept. Agr., Farmers' Bul. No. 99, 32 p., 11 fig., 1899. This publication may be had free on application to the Department of Agriculture.

of this method under such circumstances was given by a former Government entomologist at a conference on the gipsy moth in 1891. He said that he once tried to protect a cedar tree not more than 6 feet high, upon his own grounds at Washington, by hand picking. He worked during two consecutive months picking off small bags from that tree, the progeny of not more than two females. Almost daily he went to the tree and found fresh specimens which he had overlooked the day before. For evergreen trees, therefore, an arsenical spray is the best remedy. Injury by the bagworm on large trees has been absolutely stopped by spraying with Paris green at the rate of 1 pound to 150 gallons of water, the trees being completely rid of larvæ. It is easier to reach the bagworms on evergreen than on large-leaved deciduous shade trees, such as maple and elm, but if carefully carried out, spraying will result in the destruction of the bagworms, so that the collection of the bags in winter will not be necessary. Arsenate of lead at the rate of 1 pound of the prepared paste form to from 25 to 50 gallons of water will be found even more effective than the Paris green, as its greater adhesiveness renders it less likely to be washed off by rains, which in some seasons frequently occur almost daily at the time when the larvæ are beginning to work.

FIG. 10.—*Chalcis ovata:* Adult. Enlarged. (From Howard.)

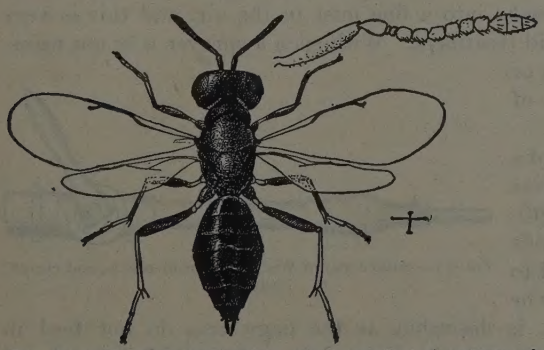

FIG. 11.—*Dibrachys boucheanus:* Adult female and antenna of male. Much enlarged. (From Howard.)

Arsenate of lead is not at all likely to produce scorching of the foliage of shade or ornamental trees or shrubs. Its natural adhesiveness is enhanced by the addition of about the same quantity by weight of resin-fishoil soap as of the arsenical used.

The question as to the best spraying apparatus to be used is an important one, the prime object being to destroy the insect without injuring the plant; the second, to avoid useless waste of the poison. Hand pumps and sprayers are unsatisfactory. One of the best types of orchard sprayer is desirable. This usually consists of a tank of about 100 gallons capacity equipped with a pump driven by a gasoline engine, mounted on a strong cart or wagon fitted with the proper length of hose and drawn by either one or two horses. Frequently one operator is enough, but two are better for most purposes, especially in the case of high trees.

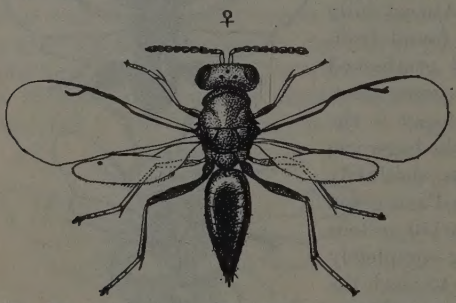

FIG. 12.—*Habrocytus thyridopterigis.* Greatly enlarged. (From Howard.)

In regard to nozzles, the older types, such as Vermorel and Bordeaux, may be used, but the new solid spray or Worthley type (fig. 13) is preferable. In case tall shade trees in valuable parks or woodlands are to be treated—trees such as spruce, cypress, hemlock, and willow, as well as maples—high-power sprayers are preferable. The type which has given the most satisfactory results in the gipsy-moth work can develop sufficient power to carry a stream which breaks into a fine mist in the air, and this is very satisfactory in rapid treatment. With such a sprayer it is not necessary to climb trees or to use small lines of hose or turrets.

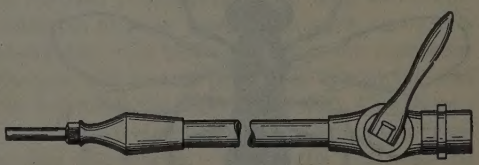

FIG. 13.—Solid spray or Worthley type of nozzle, and cut-off. (Original.)

In the treatment of a great number of trees a greater strength, namely 2 or 3 pounds of arsenate of lead to 50 gallons of water or Bordeaux mixture, is desirable, as the bagworms do not feed in masses and the poison must be directed so as thoroughly to coat and remain on the foliage where it will be eaten with the leaves. The treatment should be thorough and the application made evenly in order to secure the best results. Recent inquiry has elicited the information that arsenate of lead is being used with the highest power sprayers even at the rate of 10 pounds to 50 gallons of water, which

we consider an unnecessary expenditure. Moreover, if two or three applications are made—and this is often desirable in case this or other insects continue to injure the trees—it is almost certain to affect injuriously or destroy some forms of tender leafage if made at this strength.

The best time to apply either of the arsenicals mentioned, as in the case of most insects, is at about the time when the eggs hatch or a day or two afterwards.

PUBLICATIONS OF U. S. DEPARTMENT OF AGRICULTURE RELATING TO INSECTS AFFECTING SHADE AND ORNAMENTAL TREES.

AVAILABLE FOR FREE DISTRIBUTION.

Danger of General Spread of the Gipsy and Brown-tail Moths through Imported Nursery Stock. (Farmers' Bulletin 453.)

The Gipsy Moth and the Brown-tail Moth, with Suggestions for Their Control. (Farmers' Bulletin 564.)

The Catalpa Sphinx. (Farmers' Bulletin 705.)

The Huisache Girdler. (Department Bulletin 184.)

Report on the Gipsy-moth Work in New England. (Department Bulletin 204.)

Dispersion of Gipsy-moth Larvæ by the Wind. (Department Bulletin 273.)

FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS.

Three Insect Enemies of Shade Trees: (Elm Leaf-beetle, White-marked Tussock Moth, and Fall Webworm.) (Farmers' Bulletin 99.) Price, 5 cents.

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